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Construction of a Homopolar Dynamo

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CONSTRUCTION OF A HOMOPOLAR DYNAMO

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

IRA HAMPTON and GEORGE BOYER HERRIN

ENTITLED CONSTRUCTION OF A HOMOPOLAR DYNAMO

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Bachelor of Science in Electrical Engineering

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CONSTRUCTION OF A HOMOPOLAR DYNAMO.

The machine constructed for this thesis was designed by Johnston, Farwell, and Ray of the class of 1907. Their design may be found in the University Library under the title, "Design and Construction of a Homopolar Dynamo". It was patterned after one designed by Mr. C. E. L. Brown, whose machine seems to have been the first homopolar which could be called a success. The others had failed because of the difficulty of collecting large currents on the periphery of the rotor and because of the large armature reactions accompanying high values of current. Brown's machine, however, is said to have generated 10 volts at 1200 R.P.M. and to have showed but little drop in pressure when a current of 3000 amperes was taken from it.

The machine designed by Johnston, Farwell, and Ray is different from Brown's in having a cast steel rather than a copper armature. The fields are also cast steel. This material was selected because of its high permeability and its mechanical strength. This permits of a high peripheral speed and a comparatively small weight of material for the magnetic circuit.

Machines of this class have never been in great demand because of the low voltage feature. Some manufacturers make use of them where large currents are required and the resistance of the circuit is so small that only a few volts are necessary. The Westinghouse Electric & Mfg. Company uses one in testing such apparatus as circuit breakers. It is expected that the machine built in the University shops will be used

somewhat for metallurgical work, but more especially as a source of current for the calibration laboratory. A further use will doubtless be made of it by the Railway Department in testing rail bonds.

The designers of the machine had in addition to the work of design, made the greater part of the patterns and had obtained most of the castings. They had also done the machine work on the inside and the outside field rings, the terminal rings, a part of the armature, and had nearly completed the bearings.

ARMATURE.

The armature is a steel casting 12 inches long and 19.5 inches mean diameter. The shell having a thickness of .45 inches revolves between the two lips of an electromagnet with an air gap of .05 inches on each side. One half of the armature is weakened somewhat by the presence of a number of blow holes tho' the other side is nearly free from them. It is probably true, however, that the casting is as good as could be expected of steel. The shaft was made of machine steel turned to a diameter of 1 1/2 inches, or rather a few thousandths more than 1 1/2 inches, for it was made .006 inches larger than the hole into which it was to fit in the armature. The armature was placed in the 600,000 pound testing machine of the Mechanics Department and the shaft forced in with a maximum pressure of 54,000 pounds.

FIELD.

The field wire is wound on two cast steel rings. An air gap of .05 inches is left on each side of the armature shell, giving a total of .1 inches air gap per magnetic circuit. A den-

sity of 100,000 lines per square inch was allowed for cast steel, requiring 4,000 ampere turns per coil. In the original design a current of 4 amperes flowing thru 1000 turns was indicated. When it came to winding the field, it was evident that there was room for more than this number of turns. Because of the inclosed condition of the coils it was feared that they might heat unduly. In order to reduce this heating somewhat, 120 more turns were wound on each coil, making a total of 1120 turns per coil. The necessary current is then about 3.6 amperes instead of 4 as originally designed.

The wire used was one prepared especially for withstanding high temperature without injury to the insulation. It is known as "deltabeston", and was procured from the D.& W. Fuse Co. of Providence, R. I. This insulation is guaranteed to withstand a temperature of 350° F. The size of the wire is #15, the resistance per coil cold 15.5 ohms. The pressure necessary to drive 3.6 amperes thru a resistance of 31 ohms is about 112 volts. The 125 volt circuit in the laboratory is then sufficient for the excitation so long as the field is cool. If the field did not have a rise in temperature more than about 50° F., this circuit would be satisfactory. If the field does heat up more than 50°F., it will be necessary to use the 250 volt mains, reducing the current by means of a rheostat.

The winding was done on a large lathe in the machine shop. Record was kept of the number of turns by placing a counter on the lathe, which registered once for each revolution of the coil. Asbestos was used to insulate the coils from the metal. A thin layer of asbestos was also placed on the coil after every

fifth or sixth layer of wire.

The two terminals of each coil were brought out thru fiber tubes extending thru the outer field rings and were led to a fiber terminal board placed on one side of the machine. There is a separate binding post for each lead. Two of these binding posts are tied together to place the coils in series.

BRUSHES.

Current is taken from the rotor by twenty carbon brushes bearing radially on the periphery of the rotor, the ten of one polarity being placed at one end of the armature and those of the opposite polarity at the other end. The brushes have an active length of 3 inches and a diameter of 1 3/8 inches, each carrying 100 amperes at full load. They pass thru holes in the outer field ring, fiber being used to insulate the brush from the metal. Because of the blow holes in one half of the rotor, it was at first feared that the brushes on this side would wear away faster than those on the other, but it was found that by shifting the rotor one half inch from its original position, a fairly smooth surface could be had for all the brushes.

BRUSH HOLDERS.

It was decided that the design of the brush holders might be improved upon and instead of the three screws placed radially which were to clamp the brushes, the ring was split and clamped around the brush by a single screw. This gives a better holder contact and is more easily adjusted than could have been possible with the original design. A #3 stranded conductor is soldered into each brush holder to carry the current to the terminal-rings.

BEARINGS.

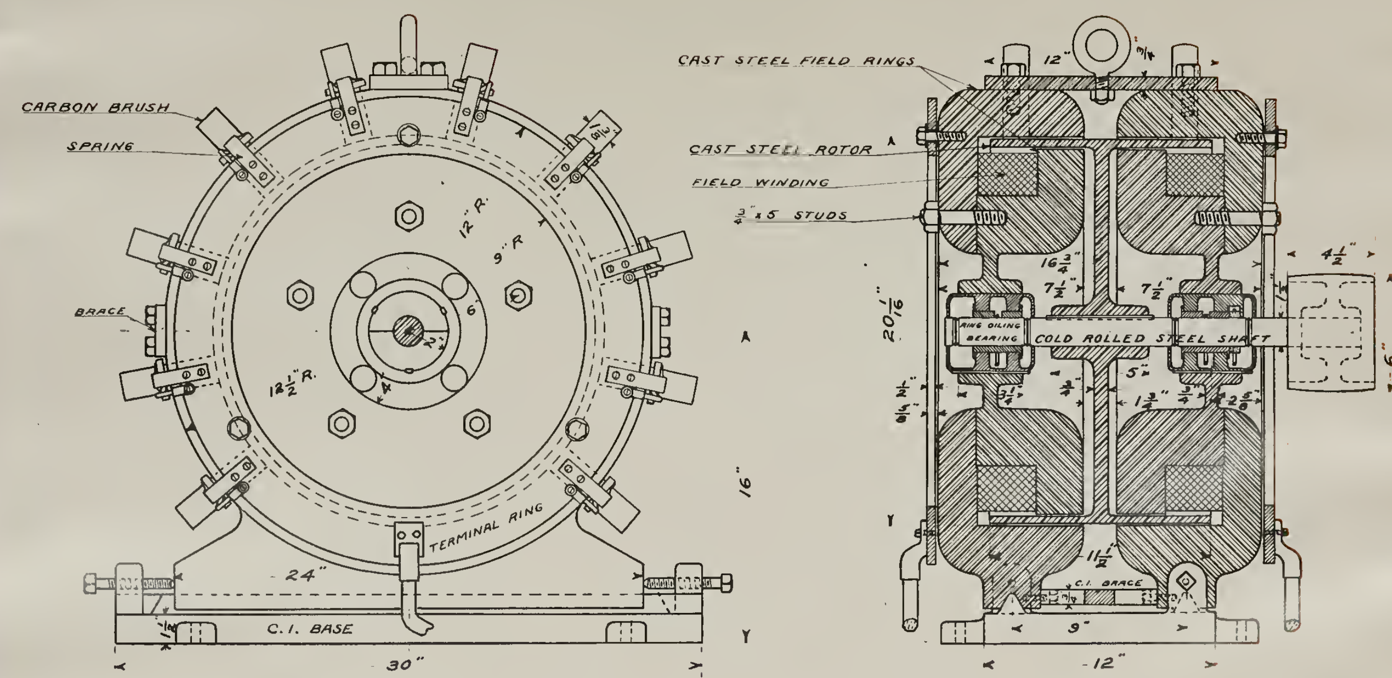
The bearing brasses were obtained from the Kerr Turbine Company of Wellsville, New York. They are of a hard bearing bronze warranted to stand 225° F. without seizing. As this metal will allow a fairly high bearing pressure to be used, the bearings are somewhat smaller than those ordinarily found on dynamos.

SPRINGS.

Due to the high peripheral speed of the armature, the collection of current is somewhat difficult and the only way in which the brush pressure may be kept practically constant is to use a spring. The springs were made of #16 B. & S. sheet brass. The end of the spring bearing upon the ring was forked so as to exert an even brush pressure on the cylinder. The other end was securely fastened to the terminal ring. The spring was then formed to exert a pressure of approximately 2 1/4 pounds on the armature. Besides serving to hold the brushes against the rotor, these springs conduct considerable current from the brushes to the terminal rings.

TERMINAL RINGS.

The terminal rings, two in number, were made of cast iron having sufficient cross section to carry full load current. One was bolted to each of the outer field rings and was insulated from the steel by fiber bushings. The current from the 20 brushes is delivered to these rings and taken to the line wire connected to each terminal by a lug.



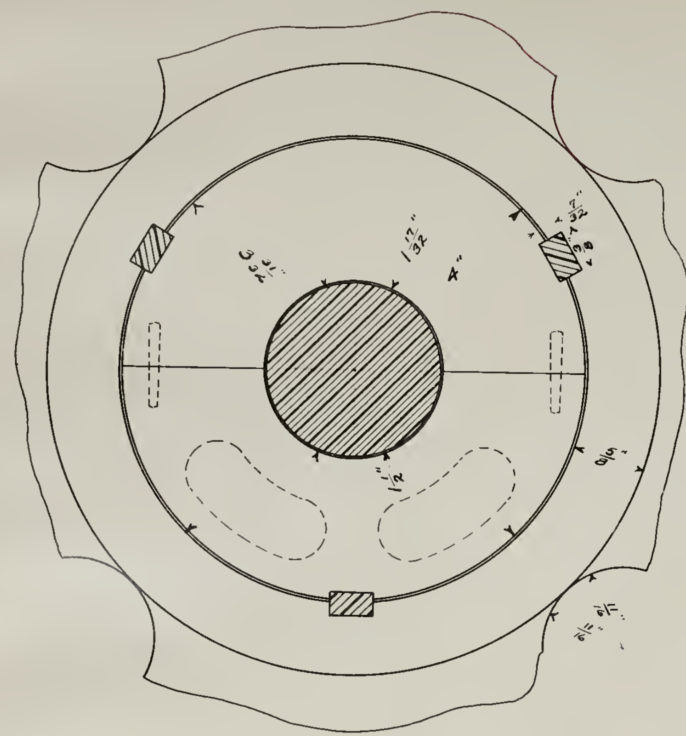
ELEVATION

SECTION

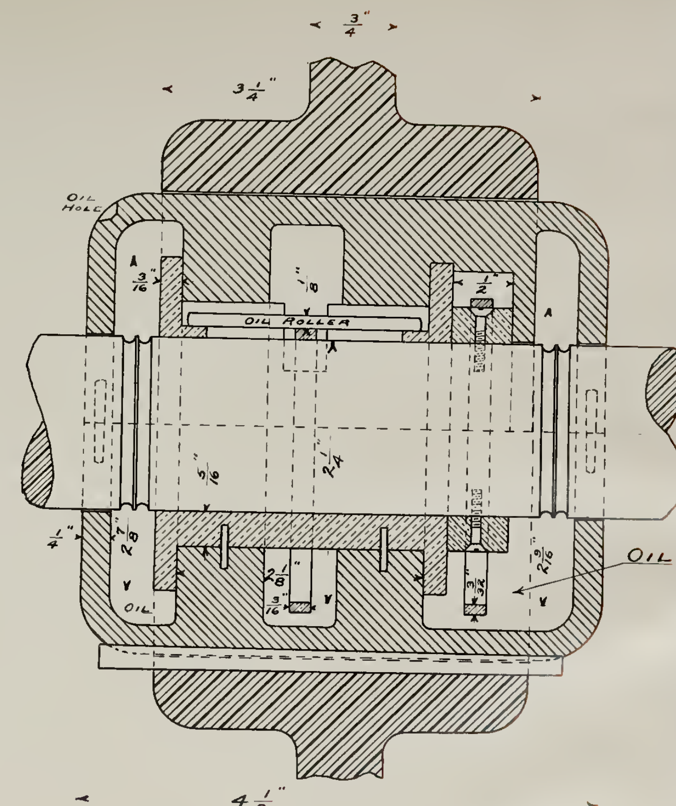
10 KW. HOMOPOLAR DYNAMO.

1000 AMP. - 10 VOLTS.

R.P.M. 2350.



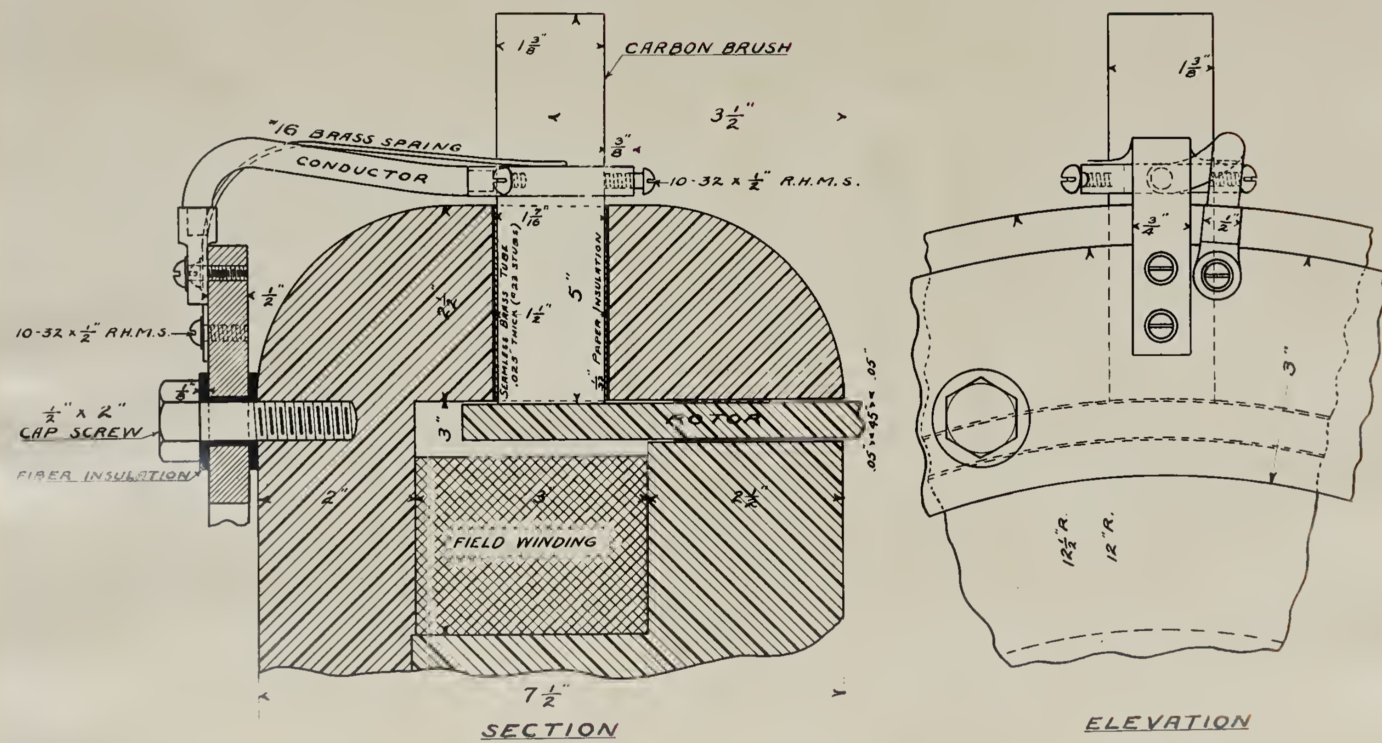
END VIEW



SECTION

BEARING FOR A 10 KW. HOMOPOLAR DYNAMO.

PROVISION FOR THRUST IN ONE BEARING ONLY.



ARRANGEMENT OF BRUSHES ON 10 K.W. HOMOPOLAR DYNAMO.

10 BRUSHES TO EACH FIELD RING : 100 AMPERES PER BRUSH.